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Rapid Exhumation of Cretaceous – Arc Rocks Along the Blue Mountain Restraining Bend, Jamaica, Using Apatite (U-Th)/He Thermochronometry

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Abstract

Partitioning of transpressive plate motion into continental deformation is complex and varies among tectonic settings. Depending on the rheological properties of the upper crust, obliquity of plate motion, and the local stress/strain-rate field(s), different structural regimes can be produced over short spatial and temporal scales. The Blue Mountain restraining bend (BMRB) in eastern Jamaica, bounded to the south by the Enriquillo-Plantain Garden fault zone (EPGFZ), presents a world-class example to study the relationship among oblique plate motion, complex fault geometry, and crustal shortening. The BMRB has the archetypical topographic form, with uplift being greatest near the fault and tapering away. Evidence for rapid tectonic uplift is easily visible in a simple topographic profile, showing rugged topography expressed by slot canyons, steep slopes, and landslides. However, the total amount of crustal shortening is not well constrained due to unmapped structures. Relative to other transpressive systems, the BMRB still has ambiguities as to whether uplift is focused along a vertical transform fault (cf. San Emigdio Mountains, California), or whether uplift is being partitioned via discrete blocks along unmapped structures (cf. San Bernadino Mountains, California). In a general sense, very little is known about when the BMRB formed, how materials are being uplifted and at what rate the Blue Mountains are rising. To address these questions, we present new apatite (U-Th)/He ages (AHe), representing exhumation from ~2-4km depth (Tc = 50-80^{o}C). Twenty bedrock samples of metamorphic, sedimentary basin-fill, and intermediate plutonic origins were collected from the BMRB, with sixteen having usable apatite crystals (i.e. size, clarity, morphology). Preliminary AHe ages range from ~1 Ma at Hagley Gap (i.e. < 0.5 km from fault) to ~6 Ma at Blue Mountain Peak (~5km from fault). With these ages separated by 1.5 km of relief, these data suggest rates of exhumation of ~0.4 mm/yr from the near-field of the bounding transform fault. Closure depths calculated for youngest sample (~1 Ma), assuming a 30 ^{o}C/km geothermal gradient, suggests acceleration in exhumation to ~2 mm/yr. This is the first evidence suggesting the BMRB is experiencing rapid exhumation and rock uplift. Additionally, the magnitude of exhumation here is high, meaning a significant portion of the EPGFZ slip is vertical along the BMRB. Compared with the San Andreas Fault (~2-3 cm/yr, fault-parallel), geodetic slip rates along the EPGFZ are much less (~ 5-7 mm/yr, fault-parallel), yet exhumation rates are comparable with both occurring at mm/yr rates. Finally, our results suggest acceleration in exhumation from 0.4 mm/yr to 2 mm/yr in the last 1-2 Ma. We speculate that either plate kinematics along the EPGFZ have rotated to more fault-normal convergence or that an increase in the efficacy of erosion began at this time. Future work will include higher temperature constraints on the thermal evolution to determine the time span in which 0.4 mm/yr exhumation was operating (i.e. Zircon-Helium), and refining the pattern of rock uplift along the fault and the role of secondary structures.